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Buried palaeosols of NW Sardinia (Italy) as archives of the Late Quaternary climatic fluctuations

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ABSTRACT

A multi-disciplinary approach was performed to investigate two compound geosols included between wind-blown deposits at the top, and interglacial (MIS 5) beach sediments at the bottom, located along the Alghero coast (North-western Sardinia, Italy). A sedimentological and morphological study was carried out on the profile in the field, and samples collected on the main pedomembers were subjected to several laboratory analyses, consisting of physical and chemical determinations on bulk samples, mineralogy (XRD), micromorphology on undisturbed samples (thin Section, SEM), and EDAX-micro probe analyses. Dating was performed by means of Optically Stimulated Luminescence (OSL). The studied geosols show the evidence of a complex pedosedimentary evolution. Around 80 to 70 ka the lower geosol underwent weathering and clay illuviation (wet and warm conditions), followed by calcification-recalcification processes (dry-contrasted), and finally by strong bioturbation. Around 70 ka the onset of the glacial period (MIS 4) is marked by the deposition of a sand dune, capping the lower geosol. These results indicate that the coastal area of the central Mediterranean kept the relatively warm conditions typical of the interglacial climate for most of the Early Würm and reached cold conditions only at about 70 ka, possibly in relation to the rapid cooling of the Heinrich event H7. The upper geosol developed on colluvial material including abundant pedorelicts and reddish earth material, deposited around 50 ka. Before being buried by aeolian sand around 43 ka, this deposit underwent pedogenesis phases possibly associated to Middle Würm interstadial events, indicating that in the study area these events were intense enough to influence pedogenesis.

1. Introduction

Red or reddish-brown palaeosols were observed in Quaternary sedimentary successions worldwide (Feng et al., 1994; Marković et al., 2008; Muhs and Budahn, 2009; Stevens and Lu, 2009; Zhang et al., 2009). The study of their pedogenic features can complement the knowledge on the palaeoenvironmental conditions related to the climatic fluctuations. Palaeosols offer long-term and fairly continuous palaeoclimatic records, in particular when placed (buried) within an appropriate sedimentological and stratigraphical context (Kraus and Bown, 1986; Mack, 1992). The term geosol has been proposed to designate the buried palaeosols that have a consistent stratigraphic position and can constitute a reference unit in pedostratigraphy (Catt, 1998).

Geosols, and more generally speaking buried palaeosols, are increasingly studied by interdisciplinary analytical methods as archives of palaeoclimatic information (Sheldon and Tabor, 2009). Under certain conditions, it can be assumed that different types of palaeosols represent distinct palaeoenvironments (Retallack, 2001). However, palaeosols preserve an intricate record in which features generated by multiple pedogenic phases are superimposed, as the result of successive cycles of soil development (Duchaufour, 1983; Schaetzl and Anderson, 2005). Buried palaeosols have the advantage of having been subjected to time-bound pedogenic periods. On the other hand, these soil-forming intervals may have been too short (centuries to few thousand years) to allow the achievement of soil–climate equilibrium conditions, and the formation of the corresponding diagnostic pedogenic features (Birkeland, 1984; Meyer, 1987; Yaalon, 1971). Furthermore, soils may

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